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ABSTRACTS

INFLUENCE OF GROWING CONDITIONS ON *Ulva ohnoi* COMPOSITION CULTIVATED IN AN IMTA-RAS SYSTEM

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Introduction

Among Integrated Multitrophic Aquaculture (IMTA) techniques, the integration of fish and macroalgae cultures in Recirculating Aquaculture Systems (IMTA-RAS) is currently one of the most promising lines of action. In IMTA systems, seaweeds remove dissolved nutrients from effluents, which reduce cost of biofiltration, and moreover can become a source of proteins and bioactive compounds for human and animal consumption or pharmaceutical applications. Removing dissolved nutrients helps to increasing sustainability of fish farms, and the new product (seaweeds) promotes diversification in aquaculture activities and can contribute to increase the economical viability of the facilities.

Growth and composition of seaweeds are related with various factors, being nitrogen supply, irradiation, and CO_2 availability the most important.

Different nitrogen content in the growing water affects the biosynthesis of different compounds such as proteins, soluble fibers, and also affects physico-chemical properties, like dry weight. Moreover, some seaweed have considerable nitrogen content plasticity, specially *Ulva sp*, whose contents in N can range from 0.5 to 5% (dw). Nitrogen assimilation can promote the synthesis and storage of different compounds such as protein, pigments, free aminoacids, nitrate, etc….

In the present work changes in biomass productivity and seaweed composition (organic nitrogen, nitrate, phosphorous and mineral contents) over time in an IMTA-RAS system under controlled conditions (light and incoming $N\text{-}NO_3$ flux) is evaluated.

Material and methods

Experiment was carried out with free-floating seaweed cultured in three indoor cylindrical tanks (17.7±0.3ºC; 90 L, 0.322 m^2) with different *Ulva ohnoi* biomass, which results in three different stocking densities: 0.8, 1.0 and 1.2 kg m^{-2}. Seaweed suspension was provided by bottom aeration, and were maintained under 0.280 mmol photons m^{-2} s^{-1} (PAR, LD cycle 12h:12h). Nutrients were supplied at 4 L/h during light cycle by two tanks of sole (*Solea senegalensis*; total biomass 25 kg, stocking density in each tank 13 kg/m^3) working in a recirculating system with a nitrifying biofilter. Water entering in seaweeds tanks has a $N\text{-}NO_3$ and $P\text{-}PO_4$ concentration about 30±2.6 and 0.85±0.06 mg L^{-1}, respectively. $N\text{-}NO_3$ and $P\text{-}PO_4$ concentrations inside the seaweed tanks were 25.2±2.9 and 0.43±0.09 mg L^{-1}, respectiveely; resulting in a decrease in $N\text{-}NO_3$ and $P\text{-}PO_4$ water concentration about 16% and 50%, respectively. *Ulva ohnoi* was harvested and weighted once a week (experiment lasted for 4 weeks), and returned to the initial stocking density. The initial and final weights of the period were used to calculate the growth (yield, g DW·m^{-2}·day^{-1}) and the specific growth rate (SGR, % day^{-1}).

Analyses were carried out weekly using rinsed seaweed samples, which were oven-dried at 60ºC until constant weight to determine dry weight (dw). From the dried samples: ash, phosphorous, organic-N and nitrate-N) contents were obtained. Total nitrogen ($N\text{-}NO_3$ + organic-N) and protein (organic-N·6,25) contents were calculated.

Nutrient assimilation per weight gain (*As*) was calculated weekly according to Eq. 1.

$$As = \frac{X_f \cdot W_f - X_i \cdot W_i}{W_f - W_i} \quad \text{Eq. 1}$$

Where *X* is the nutrient concentration in the dried sample (mg gdw^{-1}); *W*, seaweed dry weight (gdw^{-1}); *i* and *f*, initial and final. *As* (Δmg/Δg dw) is the nutrient increase (Δmg) by DW increase (Δg dw).

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Table I. Growth, yield and nutrient composition (x±sd; n=4) of cultured *Ulva ohnoi* during 4 weeks. Different superscripts show significant differences (at the 0.05 level, Tukey).

Stocking Density (SD)	0,8 kg m^{-2}	1,0 kg m^{-2}	1,2 kg m^{-2}
SGR (%dw day^{-1})	9,37±0,76 a	7,15±0,62 b	7,33±0,56 b
Yield (g dw·m^{-2}·day^{-1})	11,84±1,65 a	10,54±1,62 a	13,36±1,59 a
DryWeight (%)	10,50±0,61 a	10,92±0,92 a	11,57±1,17 a
N-NO$_3$(%dw)	0,17±0,04 a	0,16±0,05 a	0,22±0,07 a
Organic -N(%dw)	3,39±0,08 a	3,54±0,06 a	3,78±0,17 b
%Total-N(% dw)	3,51±0,14 a	3,69±0,04 ab	3,94±0,17 b
Phosphorous(mg/g dw)	3,03±0,23 a	3,06±0,30 a	3,05±0,12 a
Ashes (%dw)	26,81±3,03 a	25,06±1,93 a	23,75±1,51 a
N:P (molar ratio)	25,74±2,19 a	26,97±2,66 a	28,60±0,91 a

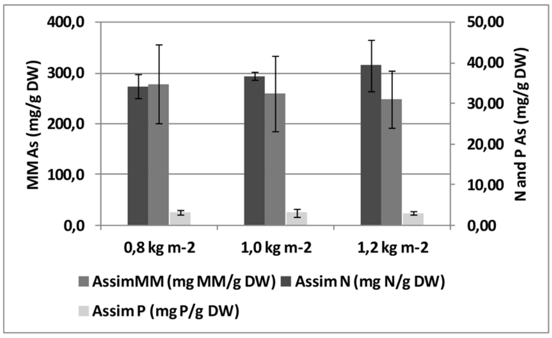

Figure 1. Nitrogen, phosphorous and mineral material (MM) assimilation (As).

There were no significant differences in assimilation between the three stocking densities (Figure 1).

Results and discussion

Table I. Growth, yield and nutrient composition (x±sd; n=4) of cultured *Ulva ohnoi* during 4 weeks. Different superscripts show significant differences (at the 0.05 level, Tukey).

No significant differences on yield were observed between stocking densities. Seaweed cultivated at 0.8 kg m^{-2} presented significantly higher SGR than those at higher densities due to the self- shading effect.

Significant differences were found in organic –N between SD 1.2 kgm^{-2} and the lower densities and also in totalN between SD 0.8 and 1.2 kgm^{-2}

Differences in nitrate and phosphorous concentrations between densities were not significant.

It seems to be a trend of increase in the N:P (molar) ratio and in dry weight when increasing stocking density and a trend of decrease in mineral content. Nevertheless differences were not significant.

P content presented low variability along time and low dependence on stocking density. N-NO$_3$ concentrations showed high variability along time but no trend to increase along time was observed (data not shown). The maximal N-NO$_3$ observed in the seaweed meet the criteria imposed by the European Union in foodstuffs(Commission Regulation (EU) Nº 1258/2011 of 2 December 2011).